Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Quantum phase transition and possible phase separation in ultra-thin doubly-connected superconducting cylinders of Al HAOHUA WANG, NEAL STALEY, BENJAMIN CLOUSER, YING LIU, Department of Physics, Penn State University — Fluxoid quantization demands that the superfluid velocity, v_s, of a doubly-connected superconducting cylinder increase as its diameter, d, decreases, leading to a destructive regime and a quantum phase transition (QPT) in one dimension (1D) - Superconductivity is suppressed around half-integer flux quanta even at zero temperature for cylinders with a d less than the zero-temperature superconducting coherence length, $\xi(0)$. We have fabricated ultrathin doubly-connected superconducting cylinders of Al over a wide range of $d/\xi(0)$ ratios, with the smallest cylinder down to 100 nm in diameter. Electrical transport measurements revealed the presence of robust step-like features in resistance *vs.* temperature curves as the destructive regime is approached. These field-induced step-like features, present only in the smallest cylinders with $d/\xi(0)$ close to or less than 1, are unrelated to sample inhomogeneity or phase slip centers, and are most likely resulted from a phase separation close to the QPT. We have also found that the normal state in the destructive regime becomes less stable as the $d/\xi(0)$ ratio increases, with the resistances at the half-flux quantum suppressed continuously from its full normal-state value. Resistance *vs.* magnetic field measurements show that the field tuned QPT is very sharp (less than 1G) with little evidence for hysteretic behavior.

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Date submitted: 30 Nov 2005 Electronic form version 1.4